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General features of 4–24-day waves in sporadic *E*-layer variations and their connection with equatorial stratospheric QBO

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Abstract

This paper summarizes the results of our research in sporadic *E*-layer (*Es*) dynamics with planetary wave periods (2–32 days) in the Northern Hemisphere and its connection with equatorial stratospheric quasi-biennial oscillation (QBO). The interpolation of averaged daily values of *Es* highest frequency (f_oEs), amplitudes of 2–32-day f_oEs oscillations and filtered 16-day f_oEs oscillations is conducted on the basis of f_oEs measurement data for 1965–1989 from the world ionosonde network. Averaged monthly values of the zonal wind $\overline{u}$ in the equatorial stratosphere at the 19–31 km height interval are used as the index of quasi-biennial oscillation of atmospheric circulation. A correlation analysis between the annual averaged values of $\overline{u}$ index and the interpolated values of f_oEs and 4–24-day f_oEs oscillations showed significant correlation in the sector of longitude from 30° to 270° (to the East of Greenwich) and latitude from 15°N to 75°N. We have developed an original algorithm for detecting a spatial motion in scalar field of any interpolated geophysical parameter in a specific local area. The algorithm is used to obtain zonal and meridional projections of local displacement of the 4–24-day f_oEs wave perturbation field in the Northern Hemisphere. A connection between the annual prevailing directions of 4–24-day f_oEs wave perturbations and the QBO phase (eastern or western) of atmospheric circulation is revealed on the basis of correlation analysis. The strongest correlation is discovered in the area around 60° N, 120° E in the case of filtered 16-day f_oEs oscillation field.

Keywords: Sporadic *E*-layer; Quasi 16-day wave; QBO; Planetary waves; Biennial oscillation; Ionospheric dynamics

1. Introduction

At present, we observe an increase of interest in investigation of influence of large-scale long-period processes in atmosphere on ionospheric dynamics in the MLT-region. It is known that the oscillations with period from 1.5 to 3 years are observed in the various parameters of *E* and *Es*-layers (Egorova and Lukashkin, 1992; Egorova, 1996; Kürschner and Jacobi, 2003). At the same time, these so-called quasi-biennial oscillations also exist in the time series of neutral atmosphere parameters (Chanin et al., 1989; Jacobi et al., 1998; Labitzke and van Loon, 2000; Labitzke, 2005; Nikolashkin et al., 2001) most of them are the indices of global cyclic processes in the Earth's atmosphere.

One of the most significant planetary phenomena is the quasi-biennial oscillation (QBO) represented by the cyclic interchange of zonal wind direction in the equatorial lower stratosphere. The average duration of the whole cycle (including western and eastern phases) is about 20–30 months at the altitude 23–24 km, where the cycle is the most pronounced (Sidorenkov, 2000).

The presence of the QBO in the equatorial zonal wind, which affects the whole stratosphere, is the cause to investigate a presumable impact of this phenomenon on ionospheric parameter variations with the same periods. If one proposes that this influence is possible, its mechanism may be highly complicated because dynamic processes of shorter temporal scale may mediate a QBO effect in ionosphere. Thus, equatorial stratospheric QBO may influence

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